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AIR WAR COLLEGE

RESEARCH REPORT

INCORPORATING FIVE NATIONS' OPERATIONAL REQUIREMENTS INTO A SINGLE AIRCRAFT

THE F-16 MULTINATIONAL FIGHTER PROGRAM VIEWED FROM THE OPERATIONAL SIDE

LT COL EINAR SMEDSVIG

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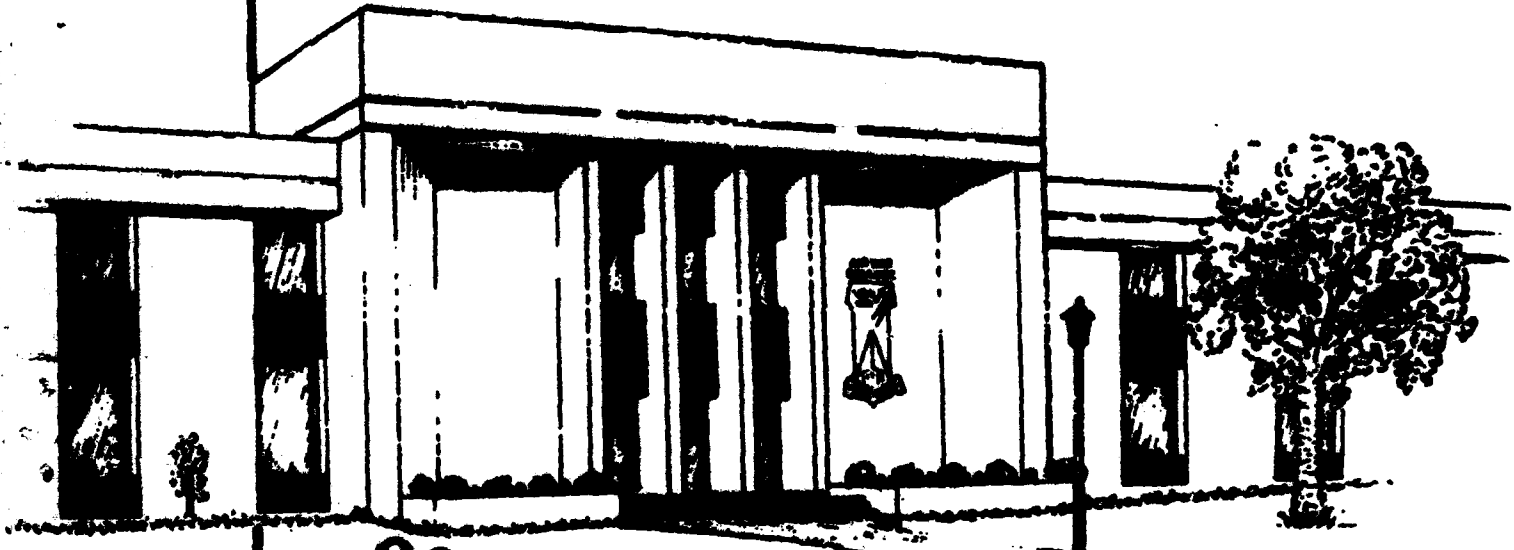

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INCORPORATING FIVE NATIONS' OPERATIONAL REQUIREMENTS INTO A SINGLE AIRCRAFT. THE F-16 MULTINATIONAL FIGTHER PROGRAM VIEWED FROM THE OPERATIONAL SIDE

BY

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

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AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: Incorporating five nations operational requirements into a single aircraft; the F-16 multinational fighter program viewed from the operational side.

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Remarks on the background for the F-16 multinational program introduce a detailed discussion of the operational facets of the total program. A description of the operational organizations follows to complete the background for the author's views on the importance of the international participation in the F-16 program. The author discusses how the international participation improved the F-16 weapon system, and continues to discuss how the F-16 operational dialogue have improved interoperability and cooperation beyond the original F-16 program. Lessons learned and potential future applications are discussed.

BIOGRAPHICAL SKETCH

Lieutenant Colonel Einar Smedsvig, Royal Norwegian Air Force (RNoAF), became involved in the multinational F-16 program in 1975. He had extensive operational background flying F-5 and F-104 aircraft before he was assigned to the F-16 System Program Office at Wright Patterson AFB in the fall of 1975. He returned to Norway in 1977, but was back in the US for F-16 checkout during the fall of 1979. He commanded the first Norwegian F-16 squadron and later the "Operations Group/Tactical Fighter School" at Rygge AFB, Norway.

Lieutenant Colonel Smedsvig was actively engaged in F-16 software coordination from 1982, and he served as the RNoAF primary member to the F-16 Operational Subcommittee 1983-86. He is a graduate of the RNoAF Staff College and a graduate of the Air War College, class of 1988.

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The author wishes to acknowledge the following persons for their outstanding support and contribution given to him during the writing of this research paper.

1. COLONEL (USAF) GARY NELSON. CHAIRMAN F-16 OPERATIONAL SUBCOMMITEE (MAR 1984 - AUG 1987)

2. CAPTAIN (USAF) MIKE CARLSON. F-16 MULTINATIONAL FIGTHER PROGRAM/PERMANENT SECRETARIAT, BRUSSELS

3. LIEUTENAT COLONEL (RNoAF) STEINAR BERG. PILOT F-16 JOINT TEST FORCE AND MULTINATIONAL OPERATIONAL TEST AND EVALUATION

CHAPTER ONE

INTRODUCTION

By 10 June 1975 the governments of Belgium, Denmark, the Netherlands, Norway and the United States had all signed a Memorandum of Understanding (MOU) relating to the procurement and production of the F-16 aircraft (6:MOU41). The signing of the MOU marked the end of years of intense marketing, negotiations and lobbying between aircraft companies, air forces and governments. The MOU committed the five nations to buy 998 aircraft; the USAF would buy 650, the remainder would be bought by the four European nations. The F-16 was the first major U.S. weapon system intended from program initiation to be co-produced with NATO allies (15:3).

The MOU is the basic charter of the F-16 program, and is specific in pointing out that the program is a cooperative program with five equal partners.(3:MOU Section A and B) During the negotiations leading up to formulating and signing the MOU, strong emphasis had been placed on the contractual, financial, and coproduction aspects of the program. The program was breaking new ground as far as coproduction, technology transfers, offsets, cost sharing and so forth. But inherent in the MOU are the operational aspects of five nations

developing and deploying, as equal partners, a high technology fighter aircraft.

The MOU stated the intent of the program, assigned the management responsibilities and established a Multinational Steering Committee (SC). Responsibility for the development was assigned to the United States Air Force Systems Command; the management would be done by the F-16 System Program Office (SPO). The SPO Director would be the single manager, and the European Participating Governments (EPG) were tasked to assign qualified personnel to the SPO.

The development of the F-16 got underway during the fall of 1975. The need for a close dialog among the multinational operational communities involved was soon recognized. After a slow start, the unique multinational character of the program became evident and gradually expanded to cover all facets of the F-16 weapon system, not limited to the aircraft and aircraft systems only.

As the program gained more and more momentum and expanded, so did the multinational involvement. From a few European pilots working intergrated in the SPO in the fall of 1975, the multinational involvement over the next years covered all operational aspects of the development, testing, deployment, modifications, training, and tactics related to the F-16 program. The Operational Subcommittee (OSC) was established in

November 1976 (6:1:1) and very soon became the center of the operational web and the main forum for operational dialog and recommendations. The OSC formed a number of Working Groups to work new problems and challenges like software modifications, commonality issues, tactics and training programs. The OSC has successfully managed to incorporate major operational enhancements and improvements while maintaining weapon system commonality.

The F-16 operational organization and spirit of cooperation laid down by the F-16 program have penetrated a number of areas not directly related to the original program. Thus the multinational aspects of the F-16 program have enhanced interoperability and standardization among the five nations. Within the F-16 program, the extensive multinational operational dialog and cooperation became decisive in formulating changes to basic aircraft systems, setting priorities for testing, formulating new requirements, and maintaining aircraft commonality. The multinational participation ensured that the F-16 would meet the operational requirements of five nations, enhanced and improved the operational capabilities of the weapon system in general, improved standardization and interoperability among NATO allies, and established a pattern for multinational cooperation that goes beyond the program.

CHAPTER TWO

MULTINATIONAL PARTICIPATION DURING THE DEVELOPMENT PHASE

The MOU states that the USAF through the F-16 SPO is responsible for the development of the weapon system (3:MOU Section A). MOU Section A states that personnel from the European Participating Governments (EPG) would be assigned to the SPO. An important point is covered in Section B where it is stated that the EPG personnel assigned to the program will be fully integrated into the F-16 management organization.

During the fall of 1975, officers from four European nations started to arrive in the SPO. Each European nation was authorized a maximum of four people, of which one was designated as the Senior National Representative (SNR). The operational background varied from country to country, but in general European representatives had extensive operational background from operating single engine, single cockpit fighters in the very demanding European environment. At this time most USAF pilots had experience from the dual cockpit, twin engine F-4. The initial period became one of learning and understanding. The EPG personnel had to be educated in the USAF acquisition process, and for the US personnel it was a time for adjusting to the fact that the F-16 program was a five nation program.

The spirit of partnership and cooperation soon was the prevailing attitude, and the EPG personnel became involved in the numerous meetings, discussions and decisions that are characteristic of a weapon system's development during the early phases. The European operational background and experience became important, in some instances critical, in defining revised requirements and formulating detailed operational requirements and possible solutions to technical problems.

The future operational role of the F-16 was different from country to country. USAF at this early stage envisaged the F-16 as an air superiority figther, the "low" figther in the "High-Low Mix" concept (13:24). European countries had a future role for the F-16 in the Air-to-Surface role, both nuclear and conventional. A number of operational issues came up during 1976 and 1977. The capability of the auto-pilot, operating modes for the APG-66 fire control radar, input to the cockpit layout, rear cockpit control authority, external tank jettison philosophy, and weapon certification priorities are just a few of the issues for which European operational personnel did have important inputs to criteria, design and solution to problems.

Working integrated in the SPO allowed the operational EPG personnel to voice opinions and suggest solutions,and thus

indicate very early what solution could be acceptable to each Air Force. But the final decisions, on behalf of the Government/Air Staff, would be taken through the interaction between the SNR and the national Air Staffs. The SNRs, who were voting members of the Multinational Configuration and Control Board (MCCB), had the final "vote" in approving or disapproving a proposed change.

Several of the European Air Forces also had peculiar operational requirements for specific modifications to the basic F-16 as defined by the Air Vehicle Specifications. Best known perhaps are the Norwegian requirement for a drag chute and the Danish/Norwegian requirement for an identification light. The operational personnel from countries with specific requirements became intimately involved in assuring that those changes were incorporated in a timely manner according to the operational requirements. The multinational operational participation in the SPO during the first years served several purposes and can in general terms be divided into four categories:

- better understanding of how the USAF acquisition system works
- keeping the national Air Staff informed what was going on in the SPO
- participate in all operational meetings to

voice opinions, views and national policy

- tracking national peculiar modifications

The main purpose for the European officers working in the SPO was to ensure that the paper aircraft of 1975, as defined by the Air Vehicle Specifications, developed into a capable weapon system with operational features and capabilities to satisfy both USAF and the European Air Forces basic requirements.

The preliminary contracts between the US and the EPGs included 14 peculiar options to the basic aircraft (12:20). The importance of maintaining a common "baseline" aircraft configuration was recognized by all five countries, and of the original 14 options, 6 were accepted by all countries, 5 were cancelled and only 3 became "peculiar" national modifications to the "baseline" aircraft (12:20-21). Those three were the drag chute, the identification light and the deletion of "Instrument Landing System (ILS)". The EPG representatives did follow up on "their" special modification(s) regardless if it was part of the "baseline" or country "peculiar". The EPAF did also accept USAF requirements, like "Air-to-Air (AA)" refueling capability in order to maintain the common baseline. In the middle 1980s the EPAF started to qualify their pilots in AA refueling adding a valuable force

multiplier to their F-16 fleet.

The first pre-production F-16s, called Full Scale Development (FSD) aircraft, were tested at Edwards AFB. This early testing was joint engineering and operational testing performed by Air Force Systems Command (AFSC) and Air Force Test and Evaluation Center (AFTEC). The unit at Edwards AFB doing the testing was referred to as the F-16 Joint Test Force (JTF). Each of the four European Participating Air Forces (EPAF) had one qualified pilot in the early test program.They were fully integrated into the Joint Test Force. The early participation in testing was considered very important by the EPAF. It strengthened the fact that the program was a true multinational program covering all phases of the development, including the testing. It gave the EPAF an early independent evaluation of the F-16 performance and capabilities. It further gave the European operational organizations the same credibility as the USAF by having one pilot more or less experienced in flying the aircraft. The European participation during the FSD testing at Edwards AFB did not have a significant impact on the test program as such. But it was very important to establish the "jointness" of the program within the established USAF test organizations. It also gave the EPAF the opportunity to have F-16 qualified pilots at the same time as the USAF.

The operational testing of the F-16 had been on the EPAF "concern list" almost from day one (6:2:Annex F). The operational testing and evaluation (OT&E) was the responsibility of the "Air Force Test and Evaluation Center (AFTEC). The EPAF concern was that their interactions in the F-16 project were tied to the Air Force Systems Command (AFSC) which only had development test responsibility (DT&E) in the program. The US Government determined in Oct. 77 (6:7:Annex J) that the EPG would have access to and participation in approx. 90% of both development and operational testing.

The Follow-on Operational Test and Evaluation (FOT&E) Phase one was conducted at Edwards AFB from 12 October 1977 to 24 January 1979. The most significant part of the early testing is the fact that part of it was done in Europe with the joint participation of USAF and EPAF pilots. This part of the testing was known as the "European Test & Evaluation (ET&E)". The ET&E lasted from 9 February through 25 May 1979. The F-16 was tested in a variety of different weather conditions, over different terrain and from different operating locations in Norway, Denmark, Germany, and England and from several different European aircraft shelters. With the EPAF pilot participation, the test scenarios were as realistic as possible and met or exceeded the areas of specific national interests. All the test data and information were available to all

participating countries. The European testing introduced and familiarized the EPAF with F-16 operations. Some EPAF pilots flying other fighter aircraft as targets were exposed to the incredible performance of the F-16, and a number of pilots were given flights in the rear seat of the F-16B (two-seater).

The European test phase was a great PR success for the F-16. It did uncover some serious deficiencies, one of which was APG-66 radar performance. The number of "false" air-to-air targets displayed by the radar system in a coastal/mountaineous terrain like in Northern Norway was not acceptable. This deficiency was now recognized by the whole F-16 community and was quickly rectified. If the Royal Norwegian Air Force had discovered the same deficiency during operational flying, the recognition of the dificiency and incorporating the fix would have taken much longer.

The "Follow-on Operational Tactics and Evaluation", phase two, and "Tactics Development and Evaluation " was conducted as a multinational project. This testing was called "Multinational Operational Test and Evaluation (MOT&E)". The MOT&E organization was comprised of pilots and support personnel from all five Air Forces. The testing was divided into a US phase between January 1979 and June 1980 at Hill AFB. The European phase was conducted from June 1980 through December

1980. During the European phase the F-16s operated from four different locations, Rygge AFB/NO, Skrydstrup AFB/DK, Leeuvarden AFB/NL and Kleine Brogel AFB/BE. The F-16s were tasked to fly typical European scenarios. The end product of the MOT&E effort was the Multinational Tactics Manual

The flight testing in Europe strengthened the operational ties within the multinational F-16 community. The close operational cooperation among five nations was a novel experience for all the participants. The common goal was to satisfy the unique requirements of five nations and at the same time keep the aircraft modifications to a minimum and have all nations accept the proposed changes to achieve the overriding goal of commonality.

As the development phase drew to an end, the spirit of partnership had succeeded in maintaining commonality, and improved the basic aircraft in numerous ways to the benefit of all five nations on a cost sharing basis. The European operational participation in the SPO certainly, on many occasions, had been the right counterbalance to the predominant engineering/managerial attitudes in the SPO. The multinational operational cooperation and participation had been established, and it rapidly expanded. The testing in Europe was a great success. It revealed weapon system weaknesses that could be corrected early in the production

run, it developed a common baseline for the operational tactics, and it installed great confidence in the aircraft performance and the entire program as being a true multinational undertaking.

CHAPTER THREE

THE ROLE OF THE F-16 OPERATIONAL SUBCOMMITTEE

The F-16 Steering Committee (SC) was established according to the MOU. The Terms of References (TOR) gives the SC the responsibility for broad policy, advice and counsel to the USAF within the terms of the MOU. The SC can establish subcommittees and establish TORs for those committees.(3:TOR 2-3).

The F-16 Operational Subcommittee (OSC) was established by the SC and given TOR by 18 Oct. 1976. The first meeting of the OSC was held in Brussels 3-4 Nov. 1976 (6:1:2). The OSC was the last of four subcommittees established by the SC, indicating the priorities of the program in 1975/76.

By the time the OSC was formed, the EPAF was well integrated in the SPO. But the need for expanding the operational dialog was recognized. The OSC was tasked to create working ties among the operational communities of the participating Air Forces, promote weapon standardization/interoperability and to promote development of mutual training, tactics and employment concepts (3:TOR:20). The OSC is chaired by an officer from the USAF Tactical Air Command (TAC).

The OSC met six times in 1977, clearly indicating the need for an operational dialog and an organization to be dedicated to the operational aspects of the program. The OSC initially

was, in general terms, fulfilling the following requirements:

- general information on the progress of the program
- initiating action items to have specific areas investigated by the SPO
- track and monitor decisions made by various agencies within the program
- discuss new or revised operational requirements, long-term plans
- voice operational areas of concern
- exchange operational experience

The items and issues discussed in the OSC would reflect the problem areas that a weapon system under development is likely to encounter. However, in the OSC the solutions to those problems would take into account European operational philosophies, requirements and experiences. The resulting recommendations or solutions would then reflect the total operational community's prioritizing and opinion. In a number of issues the difference in operational background can be seen. The rear cockpit design of the F-16B (two-seter) was a classic example of different philosophies. The USAF could accept a very austere cockpit with no or very little control of the front cockpit. The EPAF wanted a full capability cockpit --- a rear cockpit where the pilot had control and mission

essential avionics capability (6:2:4). Criteria for the F-16 autopilot reflected similar differences.

Weapon certification was from the beginning an important area as the USAF and EPAF did employ different weapons. It was important to the EPAF to ensure adequate priority in the "Seek Eagle" certification program. The employment of external tanks and jettison philosophy was an issue over many years and was never really solved. The issues were numerous; the dialog was indeed established over a very short time. Many issues would continue to surface again and again over many years. On occations new technology would solve the issues,and on other requirements one country could decide to compromise. Many requirements could not be met due to cost implications, but the issues were debated and solved within the framework of the multinational cooperation and the willingness to keep aircraft commonality.

The operational testing of the F-16 became very early an issue for the OSC (6:2:AnnexF). The EPAF had a fear of being isolated from the operational testing. The OSC discussed a number of options, and the final result was the F-16 MOT&E described in chapter two. To ensure a vehicle for future tactics and training development the OSC established the "Multinational Tactics and Training Development Working Group", commonly referred to as MTTD (6:20:7). The SC formalized the

MTTD 4 November 1982 through SC Technical Arrangement No 33 (3:SCA:133). The MTTD is not a continuously active group. It will be activated by the OSC when needed.

To ensure a timely sharing of sensitive, and important information concerning accidents and mishaps, the OSC promoted the establishment of the Safety Data Exchange Program (6:4:AnnexG) for the purpose of sharing knowledge of critical mishap information to promote flying safety. The OSC assumed in 1982 the responsibility of the "Multinational Flight Safety Working Group" (6:22:3) to further enhance the flying safety of the F-16.

The requirement for future major modification to the basic aircraft were identified early in the program. Modifications were reqiured to enhance the basic weapon system capabilities and to add new capabilities required by expanding the operational missions for the F-16. The SPO proposed a program late in 1979, later known as the "Multistage Improvement Program (MSIP) (6:14:3). This modification would give the F-16 a greatly enhanced all-weather capability both Air-to-Surface and Air-to-Air. The total modification program consisted of three phases. Stage one was production incorporation of wiring, structural strengthening and changes to the cooling system. Those changes were all aimed at incorporating additional or improved avionic systems as they would become available

later. Incorporating Stage one as early as possible on the production line would be very cost effective. The OSC became the multinational focal point in coordinating the five nations future requirements and establish what type of modifications to be incorporated as Stage one. The production version with the MSIP Stage one is known as the "Block 15" production variant, which is the final F-16A/B production variant. USAF decided to incorporate the proposed Stage two/three changes into a virtually new aircraft, the F-16C. All five nations did incorporate Stage one, even if the future operational requirements at that time were somewhat different. The importance of that decision lies in the potential for future updates and operational growth capability, all five nations have the same "base-line" aircraft. The importance of an operational dialog in achieving and, for the future, maintaining configuration commonality was reflected in the OSC's decision to establish a separate working group named the "Configuration Commonality Working Group (CCWG)" late in 1981 (6:20:8).

From early 1982 the OSC became more and more involved in the software issues and problem areas. A number of very difficult decisions had to be made by the operational communities. The OSC had the "Multinational Avionic Review Team (MART)" report directly to the OSC from August 1982. The OSC made several

recommendations to the SC on software issues and also received guidance from the SC (6:23:5). The major software issues were resolved by increasing the computer memories by a modification program known as the "Operational Capabilities Upgrade (OCU)". The OSC defined and prioritized the the OCU modifications. The OCU program does include the early production F-16, known as Block 10, since the EPAF could not accept the OCU being limited to Block 15. The USAF decision to go along resulted from the firm European position (6:29:22/26). The OCU modification program has just started and will run well into the 1990's before the complete fleet of Block 10/15 have received the modifications.

But for the OSC, the OCU is now history. Today, the OSC is looking towards the year 2000 and beyond, discussing the next major upgrade of the F-16A/B weapon system, sometimes referred to as the "mid-life update".

From a late, and very hectic start, the OSC has established itself as the hub of the operational web that had started to form in the SPO during the fall of 1975. As the European operational participation in the SPO gradually became less, the end of MOT&E in the fall of 1980 marked the end of the formalized multinational flight test effort. The OSC was by then firmly established as the focal point for all operational matters concerning the multinational F-16 program. The

operational aspects of the multinational program have changed priorities, but have experienced a continual expansion in scope. The OSC has continued to maintain its dominant role in the operational dialog and in the operational decision making process. As other aspects of the Multinational F-16 program have reached the point of exhaustion, the operational facets are very much alive and active under the auspices of the OSC.

CHAPTER FOUR

F-16 SOFTWARE CHANGES - THE NEW CHALLENGE

The F-16 weapon system incorporates a number of computers interconnected by the Avionics Multiplex Bus(AMUX). The data programs or software in these computers are the key to the operational capabilities of the weapons system. The software programs have a profound impact on cockpit switchology and the pilot's ability to perform his mission.

The F-16 uses digital computers which make reprogramming an easy task. The ease of reprogramming the computers is generally viewed as a positive feature in enhancing capabilities and incorporating new features. The challenges and problem areas lie in the making of the programs ---- the software. The process of formulating the changes, testing the new software, coordinating software changes in the different computers, and staying within the computer memory reserves turned out to be one of the major challenges for the five nation's operational organizations.

At the start of the program, cockpit changes were coordinated by the "Cockpit Review Team (CRT)" chaired by the SPO. Area of responsibility included software changes that would impact cockpit symbology and pilot switchology. EPAF pilots assigned to the F-16 SPO became members of the CRT. The proposed

software changes were during the early development phase small in magnitude. However, with more flight testing and operational deployment, the requests for cockpit/pilot related software changes increased dramatically.

The F-16 OSC did realize the necessity to coordinate software changes early in 1977 (6:2:5). But the OSC at that time felt confident that the operational requests could be handled within the logistic organization established through the "F-16 Computer Resources Integrated Support Plan (CRISP)". The implications, the complexity, and the operational potential of software related changes were not fully comprehended during the first years of the program.

In 1981/82 the production software, called "Block 15B" incorporated a number of enhancements and changes primarily based on flight testing. Some of those changes were not coordinated with the EPAF operational communities and were not well received.

In long-term plans, two weapons had been identified that could not be integrated within the existing memory reserves. Those weapons were the Norwegian Penguin anti-ship missile and the "Advanced Medium Range Air-to-Air Missile (AMRAAM).

To improve the coordination and dialog related to operational software changes with the goal of maintaining common software programs, the SPO established and chaired the "Multinational

Avionics Review Team (MART)". The different operational concepts and requirements were very visible during proposals for new software change candidates. USAF did focus on enhancing the F-16's Air-to-Surface capabilities, while some of the European countries put far more emphasis on Air-to-Air, and wanted changes that would enhance the F-16's capabilities in that field. Initially, the computer memories were large enough to accommodate the proposed changes, and the operational communities of five nations were satisfied. As the magnitude of operational software change requests increased, a very close coordination and prioritizing of what changes could be incorporated became critical.

The MART became active early in 1982. Each nation is represented by pilots, and the group discusses and decides on what operational software changes should be incorporated in future updates. Each country can suggest changes, but it takes a unanimous vote from all countries to have that change incorporated.

During 1982, the MART established itself as the focal point for all operational software changes. The complexity of software changes became very evident as the operational communities of five nations struggled to prioritize change requests for the "Fire Control Computer (FCC)", the radar system and the weapon delivery system (Stores Management System, SMS).

The overriding goal was to maintain a common software. The impact on interoperability, software support, and future updates of not maintaining a common software is enormous. It could also be the first step away from the partnership that was formed with the signing of the MOU. Consequently, the members in the MART discussed and argued, and were always able to come up with acceptable compromises.

The major software update that followed "Block 15B" was called "BLock 15S". This software modification is a result of MART negotiations. The EPAF insisted on testing this software in Europe. Flight testing with limited objectives was done during the fall of 1983 hosted by the Royal Netherlands Air Force with participation from all four EPAFs (10:4) The MTTD established by the OSC was the formal authority for conducting the testing. The testing was concentrated on evaluating operational impacts in the European theater. The testing identified deficiencies carried over from earlier software versions; 23 deficiencies were identified, among them the mechanization for firing 2.75 rockets (10:10-15). The Block 15S software changes to the radar system were also tested in Europe. This testing was conducted in two phases during May and August 1984 (11:4). The test objectives were to evaluate and verify that the Block 15S radar improvements were implemented correctly and that they did function properly in the

European theater.(11:9).

The MART was successful in formulating operational software changes within the constraints of memory reserves. However, the operational requirements to implement AMRAAM and Penguin could not be solved without modifications to the "Fire Control Computer (FCC)" and the "Central Interface Unit (CIU)" of the "Stores Management System (SMS)". Norway had initiated a study to look into the possibilities of expanding the computer memories. General Dynamics, working on a specialized Air Defense version of the F-16A/B called "ADTAC", had obviously been addressing the same problem from the ADTAC side. In December 1983 during OSC no 28, General Dynamics briefed a technical solution that expands the memory capacities of the FCC and the CIU. The OSC recommended this modification be incorporated in all F-16A/B aircraft (6:28:10) as the contractual guidance was to implement this modification to Block 15 only, as defined in Engineering Change Proposal 1085.

With this guidance the MART formulated and agreed on the "Z" version of software programs designed to go into the "big" or expanded computers. The "Z" version incorporates the software for the Penguin missile and a "beyond visual range" missile capability. The close relationship and often overlapping areas of responsibility between the MART and the "Configuration Commonality Working Group (CCWG)" established by the OSC, the

MART and CCWG were combined into the "F-16 Users Group" in August 1985 (6:33:6), and became part of the OSC structure with TORs given by the F-16 SC (3:TOR/P31). The "Users Group" continued to coordinate further refinements to the "Block 15S" software programs, updates to the radar system and the follow-on software to the "Z" version.

The "software commonality" issue has been and still is, the major operational consideration in the change process. All five nations have gained operational benefits from " staying common". The MART was the most important operational group in 1982/84 as software changes became more and more important in enhancing and improving the operational capabilities of the weapon system. In maintaining commonality, operational enhancements and capabilities suggested and pursued by one nation is inherent in every multinational F-16. The capabilities are incorporated even if a requirement does not exist today. The cost of incorporating these changes, reflecting the cumulative operative experiences of five air forces, has been very small for each nation. With common software and common documentation the potential and incentive for further cooperation will exist. In the F-16 weapon system common software programs are the key to interoperability and standardization, both in tactics and training.

CHAPTER FIVE

EUROPEAN IMPACTS ON THE F-16A/B WEAPON SYSTEM EVOLUTION

An analysis of the European impact on the evolution of the F-16A/B weapon system will have to be quite subjective. Many of the improvements may have come without the participation, perhaps at a different time. The European missions and operational scenerios forced a number of modifications early in the program that may not have been possible later. Some of those modifications increased the future potential of the weapon system. The operational interactions between EPAF and USAF requirements could in many cases make it easier for both to accept modifications. A modification required by EPAF could also be desired by USAF, and the fact that the EPAFs were the "drivers" would make it easier to accept for the USAF. With the introduction of the F-16C/D into USAF inventory, the Europeans continued to push for F-16A/B operational enhancements when TAC's interests were diminishing. With the Air National Guard and Air Force Reserve as F-16 operators, a new set of ties were formed in the interest of improving the "old" F-16A/B weapon system. The European interests in a major weapon system upgrade in the late 1990s, the "mid-life update program", will extend the operational life of the

weapon system to several decades into the year two thousand.

A. AIRCRAFT MODIFICATIONS

The US commitment to buy 650 of the "lightweight fighter," YF-16 or YF-17, was of major importance for the four European nations seeking a replacement fighter for their aging F-104s (1:19). The four nations were using the F-104s in different roles; air defence, anti-shipping, conventional attack and nuclear strike. The role of the F-16 in USAF was envisaged as the supplementary fighter to the F-15 in the "high/low mix" concept. The F-16 was to be the "low" aircraft.

The US lightweight fighter concept had driven the basic design features of the F-16. It was highly maneuverable, incorporated new features like relaxed static stability, "fly-by-wire", side stick controller, "hands on switchology", and digital avionics equipment, all features that made the F-16 an outstanding daylight air superiority fighter. The European nations never doubted that the inherent design features and performance also would make the F-16 a superior aircraft for their more air-to-surface oriented missions.

During the development phase, discussed in chapter two, the European representatives in the SPO and in the different flight test organizations were analyzing their own future role for the F-16 in relation to the aircraft as defined by the original "Air Vehicle Specifications". The EPAF require-

ments, wishes and inputs were in those years aimed at enhancing and optimizing the basic weapon system design to better perform missions like anti-shipping and air-to-surface attack. European operational expertise in the SPO was of great importance in this process.

The extremely complex coproduction program, and the unique opportunity to enhance NATO standardization were two very strong incentives to maintain a "common" aircraft. If modifications had to be implemented, all five nations should incorporate the changes. Operational modifications or retaining operational capabilities were easy to accept by all nations as long as the cost impacts were small, and did not degrade the performance. By staying common the tactical potential of the F-16 increased and all five air forces benefitted from that. The EPAF elected not to remove or deactivate the air-refueling system due to the cost of removal. Several operating modes in the radar system, related to sea surveillance, were accepted by all nations. One of the modes, "Picture Freeze", proved later to have tactical usefulness in a completely different role. The drag chute housing developed for the RNoAF was adopted by the BAF for installation of their "Rapport III" electronic countermeasure system. The drag chute modification itself was later adopted by several other F-16 customers, like Venezuela. For their follow-on

buy, the RNeAF has decided to procure the drag chute modification, and modify existing F-16s as part of the OCU modification program. The extension of the avionics multiplex bus to wing stations 3/7 was required by the RNoAF for its future anti-shipping missile. This modification was incorporated into the "baseline" aircraft; and twenty years later, this feature will allow the early production F-16s (Block 10) to employ the "Advanced Medium Range Air-to-Air Missile (AMRAAM)" from those wing stations. Testing in Norway of a proposed "reduced idle thrust" feature for the F-100 engine concluded that this modification was not required.

Production deliveries complicated incorporating operationally driven hardware modifications. The cost of retrofitting earlier production aircraft increased the total modification costs, not modifying meant different aircraft configurations. The SPO had adapted the "block" concept for incorporating modifications. The early production blocks 1,5 and 10, were all modified to Block 10 standard by all five nations, thus maintaining commonality. The operational fall out was that all five nations received a weapon system with superb operational capabilities ranging from air superiority to maritime surveillance and attack

Block 10 F-16s lack several important capabilities. In the air-to-air and surface attack roles it lacks all-weather

capability.

The F-16 "Multistage Improvement Program (MSIP)" was established to upgrade the basic F-16's tactical capabilities by incorporating existing and future technology improvements in weaponry, communications, navigation and sensors (8:11). The USAF intended to give the F-16 "beyond visual range (BVR)" capability in the air-to-air role and night precision attack capability in the air-to-surface role. The EPAF had a strong interest in improving specific tactical capabilities of the F-16. RNoAF had a definitive requirement for all weather air-to-air, BAF and RNeAF wanted to improve the night capabilities. The MSIP was conceived to consist of three stages. Stage one included modifications to the aircraft, like structure,wiring and cooling that would allow installation of advanced avionics systems as they became available. Stage one was a production incorporation of the Group A provisions for those enhancements. The MSIP program was established by USAF requirements. The SPO Director, General Abrahamson, requested the EPG during SC meeting no 21 to actively participate in MSIP and to incorporate in Stage one Group A that would reflect the future requirements of the EPAF (6:13:5). It is interesting to note that the USAF received guidance to implement Stage one prior to full EPAF participation being decided.

All five nations, however, incorporated MSIP Stage one, and the production variant is known as Block 15, the final production variant of the F-16A/B. MSIP Stage two and three never became a reality for F-16A/B. The tactical improvements required a new FCC, new radar, and new displays in the cockpit, so the F-16C/D was born. The first MSIP Stage one F-16 (Block 15) was delivered in Nov. 81 ; the F-16C/D was introduced into the USAF inventory in July 84. (8:11).

For the four European nations, Block 15 was the final production variant of the original 398 aircraft buy. The Block 15 changes are transparant to the pilot except for the increased area horizontal tail. It has the same performance as the Block 10, with greater potential for future updates.

The next major update originated from the necessity of increasing the computer memories of the F-16's FCC and "Central Interface Unit (CIU)" of the "Stores Management System (SMS)". This was an absolute requirement in order to incorporate weapon systems like AMRAAM and the Norwegian anti-ship missile "Penguin". The constraints on computer capacities were also critical for future tactical enhancements related to software programs.

The USAF decision to develop an air defence version of the F-16 Block 15 was very timely for the European requirements for greater computer capacity and all-weather air-to-air ca-

pability. This modification program, initially only aimed at Block 15, became known as "Operational Capabilities Upgrade (OCU)". The major operational features of the OCU include increasing the computer memories of the FCC and CIU, installing a Data Transfer Unit and a radar altimeter, certifying the AMRAAM on 6 wing stations (Block 15) and new computer programs. The Europeans strongly supported the OCU and pushed hard to include the Block 10 in the OCU modification program. The structural differences between the two production variants created problems, and the US interest for upgrading the Block 10s was minimal in the beginning.

With the introduction of the F-16C/D into the TAF, the "old" F-16s were given to Air National Guard (ANG) units and Air Force Reserve (AFRES) units. Those organizations had the same interests as the EPAFs in upgrading both Block 10 and 15. In defining the OCU modifications, the European requirements were the driving factors, strongly supported by ANG and AFRES. The OCU modification has just started, and Block 10 aircraft are included. With that modification completed, the F-16A/B weapon system has matured to include all-weather air-to-air and anti-shipping capability with the "Penguin" missile. The F-16A/Bs of the 1990s will have far greater operational capabilities than the original aircraft, and the commonality, the key to standardization and interoperability,

has been maintained throughout the evolution.

B. SOFTWARE

The tactical capabilities of the weapon system are to a large degree dependent on computer programs (software). Weapon delivery, radar performance, navigation, flight planning are all tied to the software in different aircraft systems. Data between the systems is automatically interchanged via the avionic multiplex bus (MUXBUS). The integration of major avionic subsystems like FCC, SMS, Inertial Navigation System (INS), Heads-Up Display (HUD), and Fire Control Radar (FCR) offered endless possibilities for different "pilot mechanizations", a term introduced early in the F-16 operational terminology. "Mechanization" is used to describe the end result(s) of switch action(s) in the cockpit. Selecting a weapon delivery mode can automatically activate the correct radar mode and display the correct sight symbology on the HUD in addition to selecting the correct weapon. Software changes are the key to different mechanizations that can decrease pilot workload, and introduce new or improve existing tactical capability.

The F-16 was the first aircraft to use digital electronic systems connected via a MUXBUS, and the potential for tactical improvements and enhancements was not recognized early in the development. To cope with the increasing requests for

software changes, the MART was established as discussed in chapter four. The software versions were originally tied to production blocks. The "Block 15B" software was introduced with Block 15, but the software was retrofitted into Block 10 production aircraft. Thus began the confusion. The changes introduced in the Block 15B were mainly generated by the test communities, and could also reflect personal preferrences. The coordination of the change requests among the five nations was not done in a satisfactory manner. Block 15B did incorporate changes that reflected the increased emphasis on the surface attack role. The "Time-on target (TOT)" clock was included, as were hands-on control of radar gain in air-to-ground modes, fuel calculations for a low level return to base, conversion of target coordinates from UTM to latitude/longitude. The radar system also incorporated improvements in the air-to-air modes (12:8-13).

The EPAF were not completely happy with the change process that produced the Block 15B. They did have a feeling of not having control over what finally would become the "common software". The EPAF did identify a need for testing Block 15B i Europe, but as test assets could not be made available (6:19:6)(6:20:AnnexD), testing was not done. Later, operational flying in Europe with the Block 15B software did uncover several errors in the software. (6:21:7).

MART opened up and strenghtend the operational dialog concerning software changes. The EPAF participated in MART from day one with experienced pilots. With more and more operational experience from flying in Europe, the EPAF were looking for the next planned update, Block 15S, to correct deficiencies of Block 15B and to introduce enhancements. Testing in Europe was considered a "must".

Block 15S was a "software only" change, not tied to any hardware changes. The software changes affected the FCC, SMS and the radar system. Major tactical improvements sponsored by EPAF were introduced with Block 15S. The "Situation Awareness Mode (SAM)" was introduced in the radar system. In SAM the radar will track one target and search for others simultaneously. This offers a major improvement in the air-to-air mode and is almost a tactical necessity for employment of AMRAAM. This mode was originated and prioritized by RNoAF. A radar "declutter option" made the radar less susceptible to false target detection. The Autobahn traffic in Central Europe was the reason for this mode (9:3). Incorporating "Bullseye Information" on the radar scope is an operational enhancement for operating the F-16 in the European Air Defense environment. It gives the pilot an accurate method of sorting multiple targets and handing target information to other aircraft (9:3).

Major enhancements to the "Low Angle Drogue Delivery (LADD) weapon delivery mode came from BAF and RNeAF and USAF. The number of programmable navigation points in the FCC was increased from 10 to 20 as strongly requested by BAF and RNeAF. The weapon load mode mechanization was completely changed to make entry of weapons, racks, fuze-settings etc quicker and more flexible. The Block 15S was tested in Europe in October/November 1983. The testing was limited to validitate Block 15S changes and impact on user operation (12:11). The testing uncovered 23 deficiencies. Testing in the US may have discovered the same deficiencies, but the error in 2.75 inch rocket firing mechanization may not have been found. The European test phase also identified 17 enhancements for possible incorporation. The Block 15S software for the radar was tested in Europe during May and August 1984 and confirmed the usefulness of the SAM and "declutter".

Block 15S used the available computer capacities. As Block 15S was finalized and variants, 15S1 and 15S2, developed, the OCU program was initiated. The software for the Penguin had been developed separately by the RNoAF. The first software programs for the OCU modified aircraft will have a common software that incorporate the anti-shipping capability in addition to Block 15S enhancements. An improved version of the OCU software is already identified. The software change pro-

cess is a continuous process, the potential for tactical improvements only limited to imagination and computer technology.

The software change process presented new challenges and opportunities in the operational dialog. Experience from five different operational communities, all flying the "common" aircraft, created a wealth of new ideas for tactical improvements through software changes. In the MART the common background made the operational dialog meaningful in evaluating the different ideas and proposals. The ground rules for incorporating changes, unanamous decision, forced each nation to prioritize and screen their own proposals. The major European contribution was tied to the experience gained from flying very diversified missions. The best tactical ideas and solutions of five air forces were forged into the software changes.

CHAPTER SIX

BEYOND THE WEAPON SYSTEM

At the start of the program, the five nations had no clear understanding of the scope of the operational dialog and co-operation that would result. With increased knowledge of the US acquisition system, the European involvement soon encompassed all areas involved in the weapon system development. The operational dialog and cooperation were also established in areas related to the future operational employment of the F-16. Only the major areas of multinational cooperation beyond the development and evolution of the weapon system will be discussed in this chapter.

A. TRAINING

The initial checkout of EPAF pilots was done in the USA. This checkout encompassed the EPAF pilots participating in JTF, MOT&E and the first cadre of operational pilots. The EPAF operational pilots received conversion training at Hill AFB integrated with USAF pilots and had the same syllabus. The conversion training exposed EPAF pilots to new thoughts and tactics, especially in air-to-air scenarios. The "common" initial conversion program trained a cadre of pilots, both in the US and Europe, that to a large degree went on to train or

organize conversion with their air forces. The standardized conversion training of both USAF and EPAF pilots was an important step in establishing a common ground for tactics development and the operational dialog in the future.

The EPAF had, as early as 1978, expressed a strong interest in sending pilots to attend the future "F-16 Fighter Weapon Instructor School" (6:8:10). In May 1980 the USAF declined to accept EPAF pilots in the "weapon school" due to security reasons (6:15:7). The possibility of arranging weapon instructor training in Europe was looked into from 1982. In May/June 1983 the four EPAF arranged the first "F-16 Fighter Weapon Instructor Training (FWIT)" course in Europe. The EPAF have continued to arrange the FWIT on a rotational basis. The need for qualified weapons instructors and operating with standardized tactics and aircraft have made it possible to share resources and train instructor pilots. Standardized weapon training has enhanced the tactical interoperability among the F-16 units in Europe.

EPAF participation in Exercise "Red Flag" started in 1984. The OSC and MTTD Working Group had a very active role in the planning process. "Red Flag" participation in 1984 was limited to three EPAF, as RNoAF for financial reasons could not participate. The cost and resources necessary to participate in "Red Flag" would normally be too high for a small Euro-

pean Air Force. The cooperation and interoperability established by the F-16 program have made it possible for the four EPAF to participate as "one unit" and sharing the support equipment and expenses. More than 50 EPAF pilots actively participated in the 1984 exercise gaining tactical experience not possible in Europe. The EPAF planned the deployment together and flew the "operational" missions as one team. The high standard of cooperation established over many years made this possible. The EPAF participated again in 1986 and will deploy in June 1988 for a third "Red Flag".

The FWIT and "Red Flag" have provided a continuous exchange of training philosophies, tactics, weapon system improvements within the F-16A/B community, and has kept the multinational cooperation alive.

B. TACTICS

The extensive MOT&E effort produced the first multinational tactics manual. The OSC has continued to upgrade this manual that provides standardized tactics and training instructions for the multi-mission F-16. The document is a living document that is continually being updated by the five nations through the OSC. This five nation interface of tactics development has ensured all five nations a document that covers all aspects of the operational roles for the weapon system. The combined experience is reflected in the document.

Different weapon employment concepts have been tested by EPAF and the results made available to the other nations. The employment of the "Rockeye" cluster bomb from the "LOFT" weapon delivery mode was tested by RNeAF/RNoAF in Norway. Live 2.75 inch rocket firings have been performed by BAF and RNoAF and the results shared.

The area of tactics development is often reflected in the discussion over software changes. In the "Users group" the exchange of new tactical ideas is often paralleled by the discussion over software changes. The FWIT has become an important part in standardizing the more flying related tactics in the EPAF. "Red Flag" and NATO exercises with USAF F-16 participation provide an important interface with US tactics development.

C. FLYING SAFETY

An exchange of safety related information was discussed very early in the program; during OSC no 4 (6:4:4). Different requirements for pilot life support equipment were discussed during the USAF/EPG life support conference in 1977. Water survival was one of the issues (6:7:AnnexN). The "Safety Data Exchange Program" was approved by the SC in April 1979. The five nations would share information about aircraft incidents and accidents. The SPO organized early in 1982 a "System Safety" directorate (ASD/YPS). The SPO intended to estab-

lish and chair a "Multinational System Safety Group". A "Flight Safety Working Group (FSWG)" had already been established under the "Logistic Support Subcommittee (LSC)", but was in the spring of 1982 not active. In May 1982 it was consensus in the OSC to reactivate the FSWG under the responsibility of OSC. The SC approved the reactivation of the FSWG under the OSC, and the USAF Inspection and Safety Center (AFISC) chaired it (6:24:6).

The FSWG started to report to the OSC from January 1983. Prior to that time the Country Update briefings had covered major aircraft accidents. The FSWG and the F-16 SSG have met combined a number of times and will continue this pattern in the future, and the Chairman/FSWG will attend the OSC meetings as required.

The flow of flying safety related information and exchange of problems have contributed to the excellent safety record of the F-16. The high performance of the F-16 caused accidents where the pilots became unconscious due to "G"-forces. It was the onset of the "G's" that introduced a new terminology, "G-LOC" (G loss-of-conciousness). This problem was first recognized by USAF. The EPAF were always informed and were briefed on several occasions. The RNeAF is now using a USAF centrifuge to train pilots to combat GLOC

The unique cockpit and flying characteristics of the F-16

caused several accidents related to pilot disorientation. The FSWG has focused on this problem, discussing the different philosophies for instrument flying training and installing different warning systems into the aircraft. By highlighting this problem, all five nations are aware of the potential for spatial disorientation in the F-16.

CHAPTER SEVEN

LESSONS LEARNED

The F-16 program has been, and still is, a very special procurement program, unique for all five nations involved. One may argue that the program is too unique in character, so that few, if any, lessons learned are applicable to other weapon system programs. The total scope of the F-16 program can be viewed from several different angles, and the experiences will be very different. Each of the participating nations can further draw very different conclusions in the same area. The cost offset has worked very well for Belgium and Holland, but not in Denmark and Norway (1:206). From the operational view, a number of lessons have been learned on both sides of the Atlantic. Experience from the F-16 program should definitely be applied in future weapon system procurement programs.

The development responsibility was assigned to AFSC/ASD. The direct European involvement during the development phase was a novel experience to all parties involved. The European operational participation was quite limited in personnel. However, the EPG influence in this phase is considered to be quite comprehensive. The EPAF representation in the SPO,

working integrated, set the stage for stressing the multinational aspects of the program. As the multinational nature gradually became understood and accepted in the numerous US organizations involved in the F-16 development, the spirit of partnership and cooperation fostered by the SPO senior management ensured that the EPG's views were taken seriously. Multinational operational representation in the SPO from the very beginning is one of the lessons learned. It provided day to day guidance to the SPO management on operational matters. The importance of operational day-to-day interface during the development phase will be applicable to future weapon system development.

Future major multinational development programs should consider sharing the development of major weapon system components. This will open up new avenues for technology transfer, cost sharing, cost offsets and coproduction. This was not part of the F-16 program, but must be investigated for future programs with the goal of reducing overall program costs and ensuring adequate industrial participation by the involved nations.

Major modifications to existing weapon systems are likely to become more and more important in the future due to the cost of procuring new systems. Production incorporation of Group A for future systems proved successful in the F-16 program as

part of the MSIP. More emphasis on potential future growth should go into the basic design if possible; with strong emphasis on incorporating Group A for future modifications as production incorporations. This will require extensive operational long term planning and the management to ensure future systems are built for the defined Group A interface.

Software management is a new concept that grew out of the F-16 program. A dedicated operational group and an organization to coordinate and prioritize operational software changes were finally established as part of the management structure. The complexity and problems related to software integration, coordination of software change requests and update cycles, weapon integration, and coordination of hardware and software modifications are just a few of the program management issues where strong and dedicated software management will be an absolute requirement for future weapon systems.

The original estimates on computer capacities required in the aircraft proved to be very conservative. The capacities were used up very early in the program leaving no room for future updates. The major lesson learned is to plan for substantial use of computer memories during the life of the weapon system. There are technical ways to ensure that the computer memories and duty cycle are adequate for the operational needs. It is significant to understand the importance of

having excess computer capacities available throughout the evolution process of the weapon system, and not let lack of computer capacities hamper the tactical evolution.

Multinational involvement in the F-16 flight testing was of great value to the total weapon system development. A multinational program should plan on performing both development and operational testing with participation from all parties involved. Part of the testing must be done in the environment of future operational flying, and performed as early as possible during the development.

In the F-16 program the OSC has played a vital role in the entire operational dialog, coordination and cooperation. A single multinational focal point for operational matters is considered absolutely necessary to ensure this dialog and coordination. The organization should be in existence at the beginning of a program, and the terms of reference should include all aspects of the operational side.

The integrated training given to EPAF pilots was extremely important in establishing the future cooperation of tactics and training. Future multinational programs should include integrated initial training with USAF if possible.

The establishment of a dialog between the flying safety organizations is another excellent lesson learned that has merit in a number of aircraft programs. The F-16 program, with its

complexity and multinational aspects, is considered to offer a very high number of lessons learned to any future aircraft program, both in the US and in Europe. However, the total experience of the F-16 program will have to be studied in detail related to a specific future program in order to employ specific lessons learned.

P

CHAPTER EIGHT

CONCLUSIONS

The F-16 Multinational Fighter Program is often perceived as and considered to be a five nation procurement program only, where coproduction, industrial offsets, cost-sharing, and technology transfers were the main issues. The program is very unique as it was the first major US weapon system intended from program initiation to be coproduced with NATO allies. Officers from the four European nations worked integrated in the SPO from the start of the Multinational Program, and had an active part in the development of the weapon system.

The scope of the operational dialog and cooperation that would result was not fully understood in the beginning of the program. From a modest start in the F-16 SPO, the operational cooperation, interface, and dialog rapidly expanded to encompass all operational facets of a major weapon system. In November of 1976 the "F-16 Operational Subcommittee" was established, and this organization has since been the focal point for the multinational operational dialog, and has fostered working ties among the operational organizations of the five air forces.

The five air forces had somewhat different operational requirements for the F-16. The operational weapon system would have to satisfy the main operational requirements of all nations. The multinational character of the F-16 program did expand the operational capabilities of the original weapon system design. The strong spirit of partnership established very early in the program created an attitude that was essential in achieving the ultimate goals of the whole program. From the operational view it was essential to maintain aircraft commonality, which is the key to NATO standardization and interoperability. At the same time, each nation had unique operational requirements that had to be incorporated into the weapon system design. Through the operational dialog the five nations were able to maintain aircraft commonality and incorporate operational capabilities peculiar to the different air forces. In maintaining commonality, the F-16 weapon system incorporates operational capabilities that satisfy or exceed the requirements of five different air forces. Maintaining commonalty has also been the key to future enhancements and modifications to the weapon system.

The operational cooperation soon encompassed initial testing and tactics development. The dialog continued to expand beyond the weapon system development to areas like flying safety, training and future tactics development.

The operational web formed during the development phase has continued to be active in defining and deciding upon enhancements and future modifications to the weapon system. It has continued to promote weapon standardization, interoperability and mutual training, tactics and employment concepts.

From an operational view, the F-16 Multinational Fighter Program is the most successful multinational program ever attempted. Even though the initial production has been completed, all of the participating nations realize the continuing benefits derived from the operational dialog and cooperation established are too valuable to let die. The operational aspects of the original program are very much alive, defining the F-16A/B for the next century. The international ties developed through the program have been strengthened, and all of NATO has benefited.

APPENDIX

F-16 OPERATIONAL SUBCOMMITTEE MEETINGS

OSC NO/YEAR	WHEN/WHERE
01/1976	3-4 NOV/BRUSSELS,BE
02/1977	11-13 JAN/THE HAGUE,NL
03/1977	1-3 MAR/BODOE AFB,NO
04/1977	25-29 APR/EDWARDS-NELLIS AFB,US
05/1977	7 JUN/BRUSSELS,BE
06/1977	22-24 AUG/KARUP AFB,DE
07/1977	9-10 NOV/WPAFB,US
08/1978	22-24 FEBR/BERCHTESGADEN,GE
09/1978	6-7 JUNE/BRUSSELS,BE
10/1978	28-29 NOV/BRUSSELS,BE
11/1979	3-4 APR/SKRYTSTRUP AFB,DE
12/1979	26-27 JUN/HILL AFB,US
13/1979	30-31 OCT/BRUSSELS,BE
14/1980	4-5 MAR/DEN HAGUE,NL
15/1980	21 MAY/HILL AFB,US
16/1980	16-17 SEPT/RYGGE AFB,NO
17/1981	10-11 FEBR/BERCHTESGADEN,GE
18/1981	27 MAY/NELLIS AFB,US

19/1981	2-3 SEPT/KARUP AFB,DE
20/1981	17-18 NOV/BRUSSELS,BE
21/1982	17-18 FEBR/MACDILL AFB,US
22/1982	12-13 MAY/BRUSSELS,BE
23/1982	3-5 AUG/BRUSSELS,BE
24/1982	17-19 NOV/TAC ZEIST,NL
25/1983	25-27 JAN/MACDILL AFB,US
26/1983	12-15 APR/BRUSSELS,BE
27/1983	9-11 AUG/BODOE AFB,NO
28/1983	13-15 DEC/PHOENIX,US
29/1984	28-29 MAR/BRUSSELS,BE
30/1984	26-2[illegible] JUN/COPENHAGEN,DE
31/1984	27-29 NOV/MACDILL AFB,US
32/1985	19-21 MAR/BRUSSELS,BE
33/1985	27-29 AUG/SOESTERBERG AFB,NL
34/1986	14-16 JAN/OGDEN ALC,US
35/1986	17-19 JUN/BODOE AFB,NO
36/1986	28-30 OCT/BRUSSELS,BE
37/1987	31 MAR - 2 APR/ORLANDO.US
38/1987	24-26 AUG/COPENHAGEN,DE

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